

**Technical Specification**

**MRTS271 Glass Fibre Reinforced Polymer (GFRP)  
Reinforcement**

**March 2023**

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## 1 Introduction

This Technical Specification applies to the supply, fabrication and placement of glass fibre reinforced polymer (GFRP) reinforcing bars for use in concrete and slope stabilisation. Typical applications would include boating facilities and areas where low electric and magnetic conductivity are important.

The design of concrete elements with GFRP reinforcement should be undertaken in accordance with an appropriate standard (e.g., CSA S806 *Design and Construction of Building Structures with Fibre-reinforced Polymers*) with material properties as per this Technical Specification.

Refer to the relevant Design Criteria for confirmation of where GFRP is permitted.

This Technical Specification shall be read in conjunction with MRTS01 *Introduction to Technical Specifications*, MRTS50 *Specific Quality System Requirements*, and other Technical Specifications as appropriate.

This Technical Specification forms part of the Transport and Main Roads Specifications Manual.

## 2 Definitions of terms

The terms defined in MRTS01 *Introduction to Technical Specifications* apply to this Technical Specification. Additional terminology relevant to this Technical Specification is defined in Table 2 below.

**Table 2 – Definitions of terms**

Term	Definition
GFRP	Glass fibre reinforced polymer, which means a fibre-reinforced composite with a polymeric matrix and continuous fibre reinforcement of glass.
Production lot	Any batch of GFRP bar produced from start to finish with the same batch of constituent materials used in the same proportions without changing any production parameter, without interruption in production and without change of equipment setup, such as cure temperature or line speed. The production lot size shall not exceed 60,000 m of straight bars of the same diameter. For bent bars and anchor-headed bars the production lot shall not exceed 6000 pieces.
Registered	Pre-qualified product or supplier in accordance with departmental registration schemes: <ul style="list-style-type: none"> <li>• <i>Supplier Registration Scheme: Bridges and Other Structures</i></li> <li>• <i>Product Index for Bridges and Other Structures</i></li> </ul> Registration of certain products and suppliers is a pre-requisite for administrator approval, not a substitute.

## 3 Referenced documents

The requirements of the referenced documents listed in Table 3 below apply to this Technical Specification. Where there are inconsistencies between this Technical Specification and the referenced documents, the requirements specified in this Technical Specification shall take precedence.

**Table 3 – Referenced documents**

Reference	Title
CSA S806	<i>Design and construction of building structures with fibre-reinforced polymers</i>
CSA S807	<i>Specification for fibre-reinforced polymer</i>
MRTS01	<i>Introduction to Technical Specifications</i>
MRTS50	<i>Specific Quality System Requirements</i>

## 4 Quality system requirements

### 4.1 Hold Points, Witness Points and Milestones

General requirements for Hold Points, Witness Points and Milestones are specified in Clause 5.2 of MRTS01 *Introduction to Technical Specifications*.

The Hold Points, Witness Points and Milestones applicable to this Technical Specification are summarised in Table 4.1. There are no Witness Points defined.

**Table 4.1 – Hold Points, Witness Points and Milestones**

Clause	Hold Point	Witness Point	Milestone
4.2	1. Acceptance of Supplier and quality plan		Submission of proposed supplier of GFRP bars (three days).
5.4	2. Substitution of different size, grade or durability class of GFRP bars		Application for substitution of reinforcement (three weeks).

### 4.2 Quality Plan

The Contractor shall prepare and implement a quality plan that includes:

- a) detailed procedures for verifying that the reinforcement has been fabricated and placed within the specified tolerances, and providing documentary evidence of conformance
- b) details of suppliers, and
- c) details of the reinforcement, bar chairs, and spacers; where required by this Technical Specification, details of approvals, certification and/or test results must also be included.

GFRP bars shall be supplied by a registered supplier. At least three days before bars are supplied, the Contractor shall submit to the Administrator the quality plan, including the registration certificate of the supplier. **Milestone**

GFRP bars shall not be delivered to the Site until written acceptance of the quality plan has been obtained from the Administrator. **Hold Point 1**

## 5 Materials

### 5.1 Glass Fibre Reinforced Polymer

GFRP reinforcement shall comply with CSA S807 *Specification for fibre-reinforced polymers* and this Technical Specification.

Bars shall be nominally circular with E-CR glass fibres and either vinylester or epoxy resin that is homogeneous throughout the cross-sectional of the bar. The GFRP bars shall have a surface deformation enhancing the bonding strength to concrete.

Bars shall be classified Grade III with respect to tensile strength and modulus of elasticity and Grade 1 with respect to durability.

Bars would therefore be designated as G[a]-EIII-D1, where [a] is the tensile strength.

The lower characteristic tensile strength for straight bars shall exceed:

- a) 1200 MPa for bars less than 12 mm nominal diameter,
- b) 1000 MPa for bars between 12 mm and 24 mm nominal diameter (inclusive), and
- c) 900 MPa for bars greater than 24 mm nominal diameter.

Since CSA S807 uses alternate standard diameters, a Canadian 25 mm bar should be considered as 24 mm for the purpose of determining minimum strength. That is, 1000 MPa as per Table 2 of CSA S807.

Conformance of reinforcement to this Technical Specification and CSA S807 shall be determined in accordance with the following clauses.

CSA S807 calls the lower characteristic strength / modulus the "classification strength/modulus". The statistical methods for determining the values can be taken as equivalent.

## **5.2 Qualification (type) testing**

Qualification testing shall be carried out in accordance with CSA S807, and additionally include testing for:

- a) compressive strength and modulus
- b) longitudinal coefficient of thermal expansion
- c) creep
- d) density, and
- e) fatigue strength

Tests noted as "[X] tests on bar size requested" in Table 8 of CSA S807 shall be conducted on two bar sizes including the most common bar size produced (e.g. on 12 and 24 mm bar).

These additional tests are considered "special application" tests in CSA S807 Table 8 and are specified at this stage to allow Designers to consider the material properties as early as possible in the design process.

Qualification testing shall be conducted by an independent NATA-accredited laboratory. Where laboratories are not available with the correct scope of accreditation, an alternate laboratory may be proposed by the supplier.

Conformance and adequacy of type testing shall be determined as part of supplier registration assessment.

### **5.3 Quality control (routine) testing**

Routine testing shall be carried out in accordance with CSA S807, with a maximum production lot size of 60,000 m of bar.

The manufacturer's quality control test report(s) shall be submitted to the Administrator for each lot of material used on the project.

### **5.4 Substitutions**

Substitution of different sizes, grades or durability class of GFRP reinforcement to that shown on the drawings shall not be made unless approved in writing by the Designer and the Administrator. The application shall be forwarded at least 3 weeks prior to the date on which the steel reinforcement is required to be placed. **Milestone**

Substitution shall be permitted only if the structure is not adversely affected by the change.

Substitution shall not proceed until the Administrator has approved the change. **Hold Point 2**

No additional payment shall be made on account of any approved substitution.

Substitution of GFRP reinforcement with steel reinforcement is prohibited.

## **6 Handling, storage and surface condition**

GFRP shall be bundled and tagged with a label identifying the bar size, shape, supplier and batch number. Reinforcement shall be protected from damage and surface contamination. During storage, it shall be stacked in racks, or on timber or other suitable material above ground and kept clean of any contamination. Bundles shall be covered with opaque films or tarping.

Bar shall be lifted with nylon or padded wire rope slings, using multiple lifting points to avoid sagging.

GFRP bars at the time the concrete is placed shall be free of mud, oil, and other contaminants that adversely affect bonding strength. Removal of contaminant materials present on the bars shall be according to the methods and materials recommended by the bar manufacturer and/or supplier.

Handling of GFRP bars shall be in accordance with the manufacturer's instructions to prevent damage. Leather gloves shall be worn at all times when handling GFRP bars.

On-site cutting will be permitted only with the approval of the Administrator. The field cutting of GFRP bars shall be permitted by means of carbide or diamond-coated blades. Eye and face protection shall be worn at all times when cutting GFRP bars.

GFRP bars shall be protected from any abrasive blasting operation in its immediate vicinity by adequate covering or wrapping with protective material.

## 7 Placing and fixing

GFRP bars shall be accurately placed in the positions as shown in the Drawings and held in the correct location during the operations of placing and consolidating concrete.

GFRP bars within the formwork shall be secured to prevent movement during concrete placement. The bars must be adequately supported or tied to resist settlement, floating upward, or movement in any direction during concrete placement.

Where the bars are to be tied together, the reinforcement shall be tied by wiring at each intersection, using either plastic cable ties, stainless steel wire or nylon ties. Where the bar spacing is 300 mm or less, only alternate intersections need to be tied.

Clearance from forms shall be maintained by use of non-metallic, registered bar chairs (refer to MRTS70 *Concrete*).

The maximum untied length of any bar shall be 900 mm and the bar support chairs shall not exceed 900 mm average spacing in each direction.

Reinforcing bars may be adjusted laterally by a maximum of 50 mm to avoid conflict with cast-in items or voids, unless noted otherwise on the Drawings. Cover to reinforcement shall not be lessened by this adjustment. The clear distance between parallel bars, other than bars lapped together shall not be less than 40 mm.

Cover to voids that will subsequently be filled with grout shall be no less than the specified cover minus 10 mm.

### 7.1 Prefabricated cages

Reinforcing cages fabricated or assembled out of position and subsequently lifted into position shall comply with the requirements of this Technical Specification and the following additional requirements.

All reinforcing cages which are required to be lifted or transported into position shall have dedicated lifting points incorporated into the cage to permit such lifting. Lifting points shall be clearly identifiable on all cages.

#### 7.1.1 Labelling cages

All GFRP bar assembly or cages shall be identified with the following information, either by tagging or a combination of labels, schedules and Drawings:

- a) fabricator's name
- b) date of manufacture
- c) drawing reference
- d) mass of cage, and
- e) for large cages, colour and location of dedicated lifting points.

For cages fabricated on site this information need not be written out on every cage. A visual inspection with accompanying documentation should be able to discern the above information.



### 7.1.2 Inspection of cages fabricated outside of Australia

All GFRP bar cages fabricated outside of Australia shall be visually inspected by the Administrator in Australia at a suitable location.

## 8 Splicing of reinforcement

Splicing of GFRP bars shall only be undertaken through lapping of bars and occur only in the locations shown in the Drawings, unless otherwise approved by the Administrator. The length of lap splices varies with concrete strength, type of concrete, grade and size of the bar, spacing and cover. In the absence of other specifications, an overlap of at least 40 bar diameters shall be utilised. Where practical, splices in GFRP bars shall be staggered. Where splices cannot be staggered, the splices lap length shall be increased by 1.3 times the standard lap length. All GFRP bars shall be spliced in such a manner as to maintain specified clear cover to the surface of the concrete.

## 9 Tolerances

GFRP reinforcing bar shall be fabricated to the shape and dimensions shown in the Drawings and within the following tolerances in Table 9(a).

**Table 9(a) – Fabrication tolerances**

<b>Bar or mesh</b>	<b>Tolerance</b>
On any overall dimension for bars and mesh except where used as a fitment: Length ≤ 600 mm: Length > 600 mm:	- 25 mm, + 0 mm - 40 mm, + 0 mm
On any overall dimension of bars or mesh used as a fitment: For deformed bars and mesh: For plain round bars and wire:	- 15 mm, + 0 mm - 10 mm, + 0 mm
For all precast / prestressed concrete:	± 5 mm

Notwithstanding compliance with any other tolerance specified in this Contract, the deviation from the specified position of steel reinforcement must not exceed the tolerances in Table 9(b).

**Table 9(b) – Positional tolerances**

Position	Tolerance <sup>1</sup>
<b>Controlled by Cover</b>	
In beams, slabs, columns and walls	- 5 mm, + 10 mm
In slabs-on-ground	- 10 mm, + 20 mm
Formed surfaces <sup>2</sup> and unformed finished surfaces	- 5 mm, + 10 mm
In footings cast in the ground	- 10 mm, + 40 mm
<b>Not Controlled by Cover</b>	
The location of steel reinforcement on a profile	± 10 mm
The position of the ends of steel reinforcement along the line of the bar	± 50 mm
The spacing of bars in walls and slabs, and the spacing of fitments, including in precast concrete elements	The greater of 10% of the specified spacing and 15 mm.

Notes:

<sup>1</sup> A positive value indicates the amount of cover increases, and a negative value indicates the amount the cover decreases.

<sup>2</sup> Concrete cast against a blinding concrete layer is considered to be formed.

